Radiographic Diagnosis of Intestinal Perforation in Early Infancy

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■ *Records of 25 patients with intestinal perforation in early infancy who were treated at the Los Angeles County General Hospital in a period of 15 years were reviewed. Sixteen had roentgen evidence of pneumoperitoneum, and nine did not. The mortality rate was 94 per cent in the group with pneumoperitoneum, 78 per cent in the other, and 88 per cent overall. Multiple sites in the gastrointestinal tract were involved, and the causes of the lesions were diverse and frequently obscure. Prematurity, obstetrical and iatrogenic complications, and congenital anomalies were factors often associated with intestinal perforation. Roentgen features appeared to offer the best hope for diagnosis and appropriate treatment.*

INTESTINAL PERFORATION is a serious condition at any age, but especially so in the young infant. The cause of many perforations in this age group is poorly understood. Anoxia with intestinal ischemia, unrecognized trauma and congenital smooth muscle defects in intestinal wall have been suggested.[1,5,10,11,15] In most instances it is difficult or impossible to ascribe a specific cause.

We have observed 25 cases of intestinal perforation in early infancy at the Los Angeles County General Hospital over the past 15 years. Of these, 16 had roentgen evidence of pneumoperitoneum and nine did not. The clinical signs of intestinal rupture in infants are nonspecific, and frequently the symptoms are those of respiratory distress or septicemia. The physical findings are usually abdominal distention, tachypnea, vomiting and obtundation. Clinical diagnosis is usually late. Radiographic evaluation is helpful in early diagnosis if ileus or intraperitoneal fluid or air is detected.

In the group with pneumoperitoneum, most of the cases occurred in the first week of life (Table 1). The group of patients without pneumoperitoneum had no apparent peak incidence. There were 14 males to 11 females in both groups combined, and this does not appear to be a significant sex difference. Similarly with regard to racial differences, there were 15 Caucasians and 10 non-Caucasians in the groups combined. Because of the small number of cases, and the type of population sampled at this hospital, we do not feel that a significant racial factor was shown in our data.

There are many sites in the intestinal tract involved in both groups (Table 2). Bowel obstruction was encountered in a few cases, but in many cases no cause could be found. There were no gastric perforations without pneumoperitoneum.

Many of the patients had congenital anomalies. The gastrointestinal anomalies included congenital bands, esophageal, biliary, duodenal and jeju-

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TABLE 1.—*Clinical Data on 25 Infants with Intestinal Perforation*

	Pneumoperitoneum	*No Pneumoperitoneum*
NUMBER OF CASES	16	9
AGE		
Under 1 Week	9	3
1 Week to 1 Month	2	2
Over 1 Month	5	4
Range	1 Day to 12 Weeks	2 Days to 6 Months
SEX		
Male	10	4
Female	6	5
RACE		
Caucasian	7	8
Non-Caucasian	9	1

nal atresia, malrotation, omphalocele, mesenteric defect with internal hernia, situs inversus of liver and stomach and megacolon. The cardiovascular anomalies were patent ductus arteriosus, atrial and ventricular septal defect and transposition of great vessels. There was one case of multiple epiphyseal dysplasia, congenita (stippled epiphyses).

The incidence of prematurity and obstetrical complications also was fairly high. Premature rupture of membranes, intrauterine fetal distress, cesarean section in a diabetic mother and complicated breech delivery were the obstetrical problems, aside from premature delivery. Nine of the 25 patients (36 per cent) were premature infants.

In the iatrogenic category, there was one rectal perforation by a thermometer. There are only five other such reported cases in this age group.[2,4,7,14,17] In four of the cases of gastric perforation, there was a questionable relationship between perforation and nasogastric intubation. The shape and large size of the gastric defects were such as to make one think of traumatic laceration, although this could not be proved. There are three published cases in which gastric perforation was attributed to intubation.[3,7,11]

The mortality in the present series was high—94 per cent in the group with pneumoperitoneum, 78 per cent in the group without and 88 per cent overall. The only survivors were patients in whom surgical exploration was done. These figures are not unusual. Nice and Mouton[9] reported a series of 16 perforations in this age bracket with a 75 per cent mortality. Freeark and coworkers[4] reported 87 per cent mortality in 15 cases, and Tucker and Izant[16] a 50 per cent mortality in 26 cases.

It has been our experience that diagnosis of the site of perforation clinically or radiographically from plain films is almost impossible. The use of contrast media for gastrointestinal examination in suspected perforation is not productive of much useful information, delays operation, and may be harmful. Two of our cases with colon perforation had free spill of barium into the peritoneal cavity. While we may hope that better obstetrical and nursing care, prevention of prematurity and awareness of iatrogenic complications may reduce the factors predisposing to perforation, the best chance for cure is early diagnosis and prompt surgical exploration. The radiologist can perform a vital service in this regard.

The roentgen signs of perforation are pneumoperitoneum, peritoneal fluid and bowel distention. The features in radiographic diagnosis of pneumoperitoneum have been well described.[6,8,12,13] Some cases are easily diagnosed, while others are diffi-

TABLE 2.—*Site and Type of Intestinal Perforation in 25 Cases*

Site of Perforation	*Nature of Lesion*	
	Pneumoperitoneum (16)	*No Pneumoperitoneum (9)*
Stomach & Duodenum	Idiopathic gastric (3) Gastric ulcer (2) Duodenal ulcer (1)	Duodenal ulcer (5)
Jejunum & Ileum	Postoperative leak, ileal (3) Mechanical obstruction, ileum (3) Idiopathic ileal (1)	Jejunal ulcer (1) Mechanical obstruction, ileum (1) Meckel's diverticulitis (1)
Colon	Idiopathic transverse (1) Traumatic rectal (1)	Transverse, [Hirschsrung's] (1)
Cecum	Necrotizing colitis (1)	

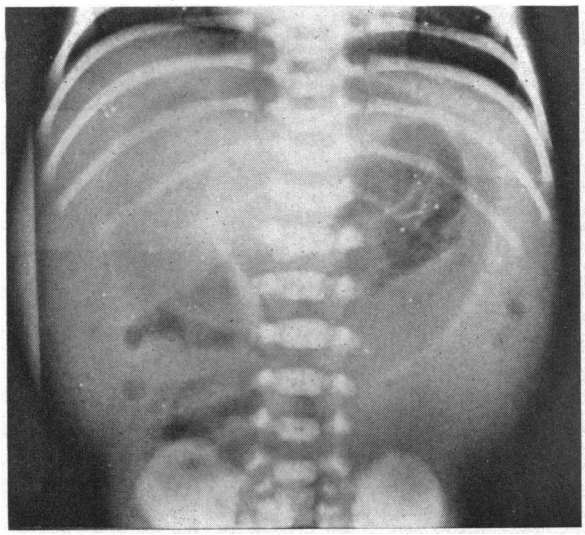

Figure 1.—(Case 1) Supine film with pneumoperitoneum, seen as "football sign." The patient had necrotizing colitis of cecum with perforation.

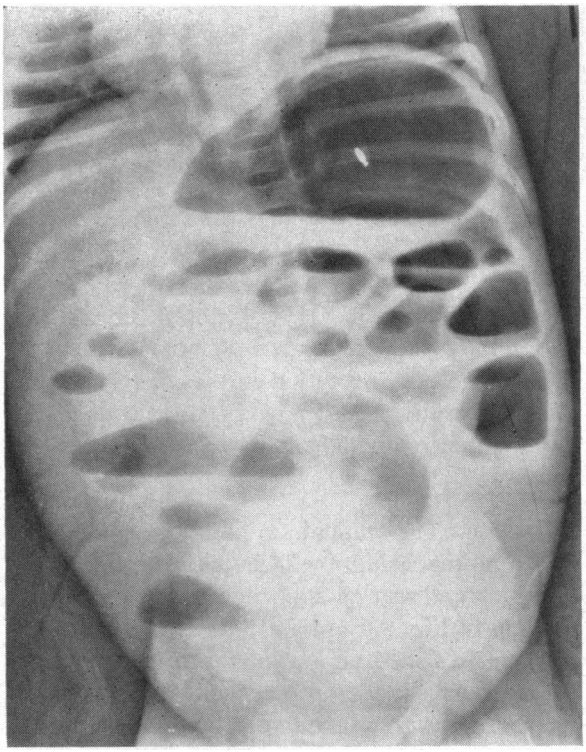

Figure 2.—(Case 2) Air in lesser peritoneal sac; peritoneal fluid; adynamic ileus. The patient had a perforated duodenal ulcer.

cult. Chances of detecting small amounts of free air are improved by taking two views of the abdomen, a supine and either an upright or lateral decubitus film. We shall present several illustrative cases from our series.

Reports of Cases

CASE 1. A premature boy became ill at two days of age. Pregnancy had been complicated by rupture of the membranes one month before delivery. The baby appeared healthy at birth, but on the second day abdominal distention developed. However, the baby continued to pass meconium. A supine radiograph of the abdomen taken on the second day of life (Figure 1) showed gas in the stomach and some slightly distended gas-filled small bowel loops. There was a faint central oval radiolucency, and the falciform ligament was outlined. This is an example of the "football" sign, the oval radiolucency representing the ball, and the falciform ligament the lacing of the ball. Small amounts of air on a supine film collect under the anterior abdominal wall and over the liver, and can be subtle enough to be overlooked, unless one is specifically looking for it. At operation peritonitis and a cecal perforation due to necrotizing colitis were observed. There was also a defect in the mesentery with a closed loop ileal obstruction secondary to an internal hernia. The baby died one day after operation with Gram-negative septicemia. Autopsy was refused.

CASE 2. A two-month-old girl was admitted with a one-week history of diarrhea and dehydration. Stool cultures grew normal flora. Three days after admission abdominal distention was noted. On the tenth hospital day "coffee ground" emesis occurred, and abdominal roentgenograms were obtained. On the supine film, gas-distended intestinal loops were seen. Air-fluid levels in them were shown on the upright film (Figure 2). The hazy density to the abdominal contents and separation of intestinal loops suggested peritoneal fluid. Two large gas shadows were present in the left upper quadrant, one of them the gas-filled stomach, the other gas in the lesser peritoneal sac. This manifestation of pneumoperitoneum was not recognized at the time the films were taken. The patient died one day later. At autopsy, a duodenal ulcer with posterior perforation and peritonitis was found.

CASE 3. The patient was a three-weeks-old girl who had been born prematurely, by breech delivery, to an 11-year-old mother who had been impregnated by her father. The baby had short humeri, flexion contractures of the hips and knees, cataracts and heart murmurs. Skeletal roentgenograms showed multiple epiphyseal dysplasia (stip-

pled epiphyses). At three weeks of age, the infant became ill, with vomiting, constipation and abdominal distention. Abdominal films at this time showed free air. This was seen on the supine film as visualization of both walls of bowel loops, and more obviously on the upright film under the left hemidiaphragm. There were also distended loops of bowel with air fluid levels. At operation a perforation of the right transverse colon with peritonitis was found, as well as incomplete malrotation with a high cecum. The perforation was closed, but the baby died a day later with Gram-negative septicemia. At autopsy, no abnormalities in colon musculature, ganglion cells or blood supply were observed, and there was no evidence of bowel obstruction. Other findings were pulmonary stenosis, ventricular septal defect and stippled epiphyses.

CASE 4. A girl baby, premature, who was being gavage-fed had jaundice at two days of age and passed foul meconium and yellow stools. At five days, lethargy, irritability, anorexia and abdominal distention were noted. There was no emesis or constipation. Abdominal films were obtained at this time (Figure 3). The supine film showed the "football" sign and separation of gas filled loops indicating peritoneal fluid. The decubitus view showed a more obvious accumulation of air between the liver and costal margin. The baby died before operation could be done. At autopsy, a 1.5×.8 cm diamond-shaped laceration of the mucosa of the posterior wall of the stomach, with a 5 mm perforation through the serosa, was noted. The pathologists were uncertain whether the cause was ulcer, mural defect or traumatic laceration, but at last agreed on gastric ulcer.

CASE 5. The patient was a boy born at term, after premature rupture of membranes, to a mother with a positive reaction to a blood test for syphilis. Cyanosis and abdominal distention were noted on the first day of life, and were treated with oxygen and the placement of nasogastric and rectal tubes. The stools were normal. Subsequently, the baby vomited a green substance and passed blood-tinged stools. A supine abdominal radiograph at seven days of age revealed considerable free air, with a "football" sign and outlining of lateral peritoneal walls. At operation the same day, a 2 cm tear along the greater curvature of the stomach was found, as well as some thin duodenal bands and the presence of peritonitis. The bands were

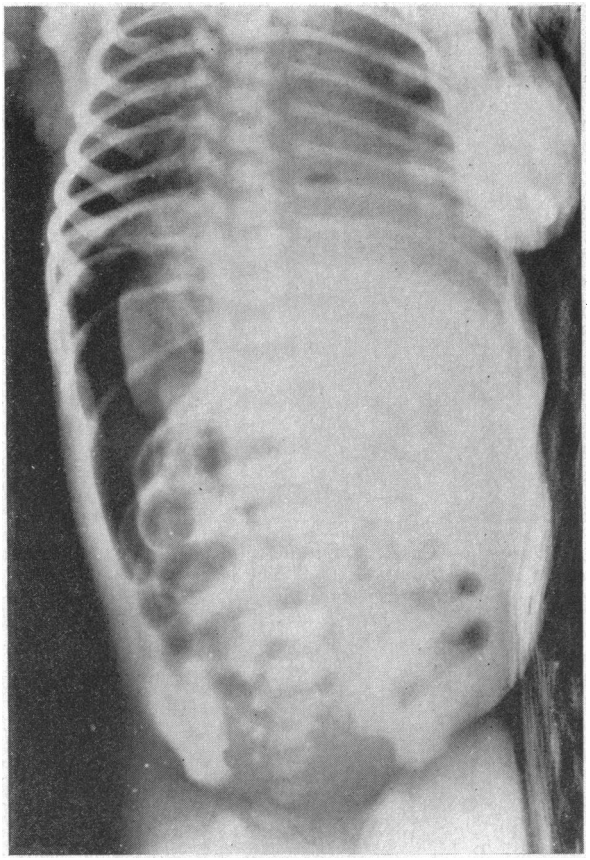

Figure 3.—(Case 4) Decubitus view, with free air between liver and costal margin, and outlining outer wall of intestinal loops. Perforated gastric ulcer.

freed and the perforation was closed. The patient died in the postoperative period. Autopsy revealed hemorrhage and ulceration in the area of the repaired laceration. The final pathologic diagnosis was spontaneous (idiopathic?) perforation of the stomach.

CASE 6. The patient, a premature boy, had passed no meconium by 24 hours, and abdominal distention and regurgitation were noted on the second day of life. An upright roentgenogram of the abdomen revealed air under the diaphragm, gas-distended intestinal loops and a suggestion of peritoneal fluid. At operation volvulus of the terminal ileum with a gangrenous perforation, but no malrotation, were noted. The patient died in the postoperative period and autopsy was refused.

CASE 7. Abdominal distention, vomiting and anorexia developed in a five-day-old girl one day before admission. She was treated with nasogastric intubation. Abdominal radiographs on admission showed a large collection of free air over the

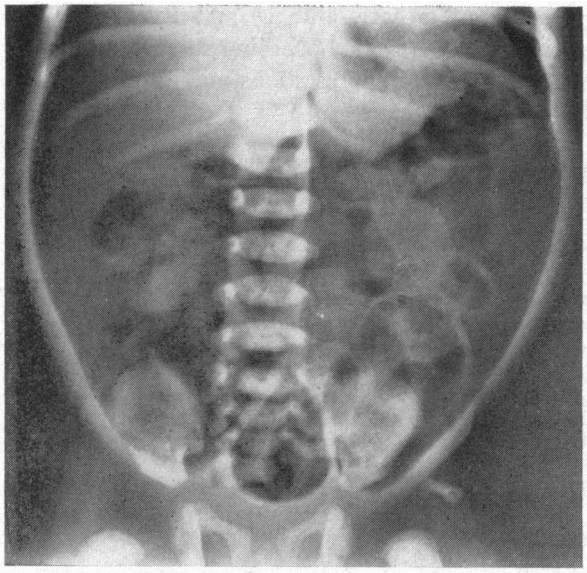

Figure 4.—(Case 8) Large pneumoperitoneum with air along the lateral peritoneal walls and over the liver. Spontaneous perforation of stomach.

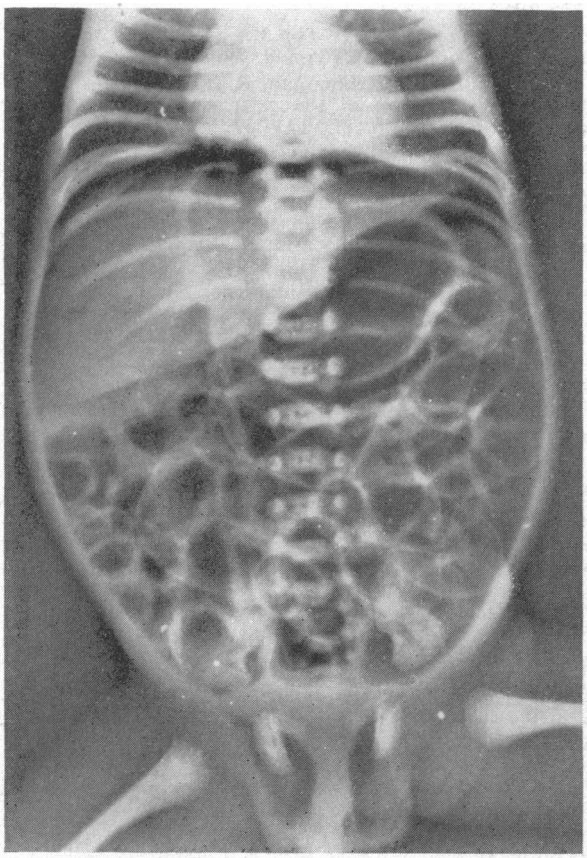

Figure 5.—(Case 10) Massive pneumoperitoneum. Note air under the diaphragm, in the scrotum, outlining falciform ligament, lateral peritoneal walls, and outer walls of bowel loops. Adynamic ileus. Traumatic perforation of rectum.

right hemi-abdomen and liver on the supine view, and under the diaphragm on the upright film. At operation a 3 cm tear in the greater curvature of the stomach was seen. This was repaired, and the child recovered. Biopsy was not obtained. Final diagnosis was spontaneous (idiopathic?) perforation of the stomach.

CASE 8. A boy, born at term after intrauterine fetal distress, had been in respiratory trouble since birth. He required a tracheal catheter and oxygen. Meconium was passed. Emesis occurred on the first day, and abdominal distention on the third. Nasogastric intubation partially relieved the distention. Abdominal radiographs on the third day (Figure 4) revealed a large amount of free air over the liver, under the diaphragm and outlining the lateral peritoneal walls. At operation, peritonitis and a 5 cm tear along the lesser curvature of the stomach were noted. The perforation was closed. The patient died postoperatively and autopsy was refused. There was no biopsy of the stomach. The final diagnosis was spontaneous (idiopathic?) perforation of the stomach.

CASE 9. A girl, born at term, was admitted to hospital at one month of age with jaundice progressive since birth. Physical findings were icterus and enlargement of the left lobe of the liver. Mild hemolytic anemia due to ABO incompatibility was present. The clinical course was complicated by sepsis, but after prolonged medical treatment the infant's physical condition improved. The jaundice persisted, however. Laparotomy was done at two months of age, and atresia of the common bile duct, with biliary cirrhosis, was observed. Choledochoduodenostomy was performed. Also noted was situs inversus of the liver and stomach. The postoperative course was complicated by sepsis, but the infant appeared to be making a reasonable recovery. A month after laparotomy, abdominal distention and vomiting developed. Roentgenograms of the abdomen at this time revealed free air in the right upper quadrant and under the diaphragm, as well as gas-distended intestinal loops with air-fluid levels on the upright film, suggesting bowel obstruction. Death occurred suddenly, before operation could be done. At postmortem examination a band obstruction of the terminal ileum, with perforation and peritonitis, were observed.

CASE 10. A boy, born prematurely, was trans-

ferred to the Los Angeles County General Hospital from a suburban hospital at three days of age. On admission, physical findings were cyanosis, tachypnea, retractions and abdominal distention. The rectal temperature was 95°F. Meconium was passed. A supine radiograph on admission (Figure 5) showed massive pneumoperitoneum, with air under the diaphragm, in the scrotum, over the liver outlining the falciform ligament, and outlining the lateral peritoneal walls and outer walls of bowel loops. A pattern of ileus was also present. At operation, a perforated opening the size of a thermometer bulb was found in the anterior rectal wall just above the peritoneal reflection. Peritonitis was present. The patient died during operation. Autopsy revealed no defects in blood supply, no ganglion cells or smooth muscle of bowel wall and no evidence of malrotation or bowel obstruction.

CASE 11. The patient, a girl, was delivered at term, of a diabetic mother, by cesarean section. She had had respiratory distress with cyanosis from birth. Roentgenogram obtained on the third day of life revealed pneumonitis and an intestinal pattern compatible with mild, adynamic ileus. There was no evidence of free intraperitoneal fluid or air. Subsequently, abdominal distention developed, and the infant died on the fifth day. Repeat films were not obtained before death. Postmortem examination revealed pneumonitis, perforated duodenal ulcer, peritonitis and Gram-negative septicemia. It is possible that had films been obtained after abdominal distention developed, they would have revealed free air.

Conclusion

Early radiographic examination of the abdomen appears to be the most important step in improving the mortality rate associated with intestinal perforation in early infancy. Awareness of the roentgen features, predisposing factors and nonspecific clinical manifestations may lead to earlier diagnosis and treatment.

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